Osteoarthritis and Bone Marrow Signal Changes

10

10.1 Osteoarthritis

- Osteoarthritis (OA) is a joint disease represented by degeneration of cartilage, meniscus, subchondral bone, and other tissues due to ageing and mechanical load, abnormal proliferation of synovium, and bone and cartilage overgrowth.
- Of all joints of the body, the tibiofemoral joint of the knee is the most commonly affected site.
- Common in elderly women.
- Medial knee OA and varus deformity due to a loss of the medial joint space is more common than lateral knee OA.

Key points for MRI interpretation

- Joint space narrowing, osteophyte formation, sclerosis of subchondral bone, and cyst formation, all of which can also be detected by radiography. MRI-specific findings include articular cartilage thinning and loss, meniscal damage, and degeneration (Fig. 10.1).
- Due to the high frequency of medial knee OA, deformity, and degeneration of the middle and posterior segments of the medial meniscus is frequently seen.
- Joint effusion is commonly seen, reflecting the presence of cartilage and meniscal lesions (Fig. 10.2). Joint fluid in OA

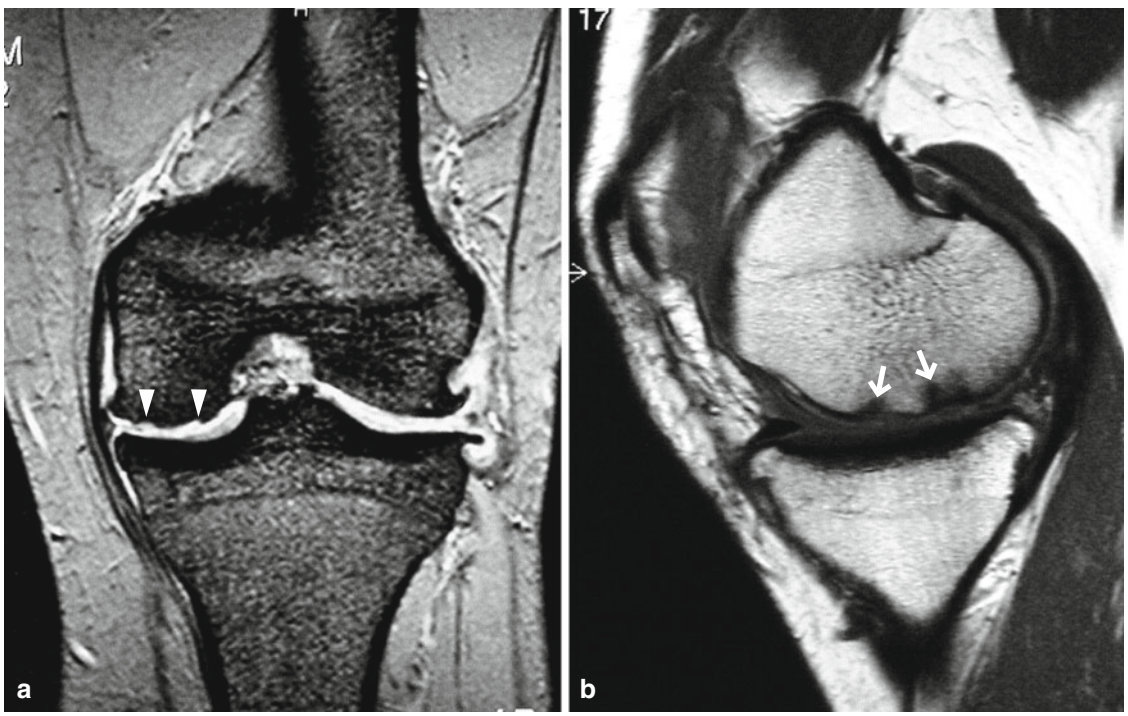

Fig. 10.1 **Knee osteoarthritis**. A woman in her 50s. (**a**) Coronal T2* WI and (**b**) PDWI. Medial joint space narrowing and the osteophyte formation are seen in the tibiofemoral joint. In the weight-bearing part, there is articular cartilage thinning (*arrowheads*), and subchondral sclerosis (*arrows*), degenerative tear, and loss of meniscus are seen

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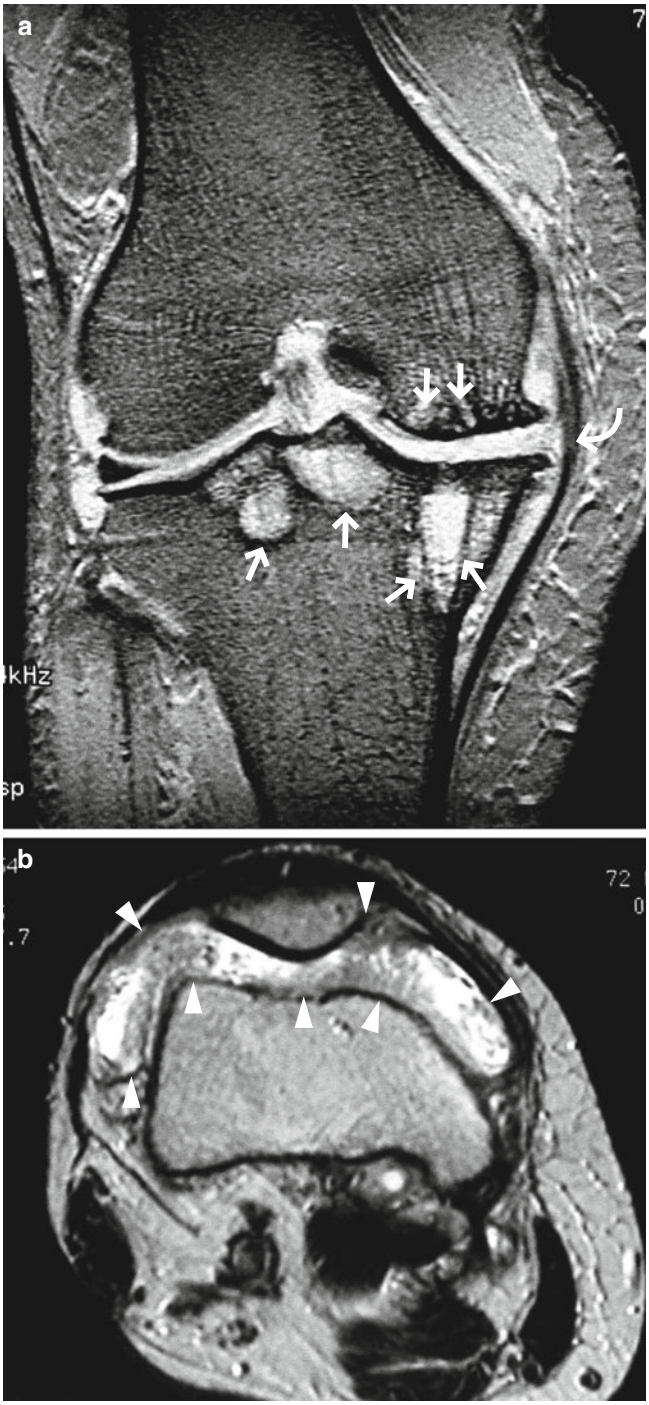

Fig. 10.2 OA and joint effusion. A woman in her 70s. (**a**) Coronal T2*WI and (**b**) axial T2WI. There are numerous subchondral cysts mainly in the medial tibiofemoral joint (*arrows*). MCL is extended in a bow shape due to the presence of medial osteophytes (*curved arrow*). Medial meniscus is severely degenerated and is almost completely macerated, but the medial joint space is not completely lost. A large amount of joint effusion is present together with proliferated synovium (*arrowheads*). Differential diagnosis may include synovial disorders such as pigmented villonodular synovitis in certain cases

is clear, but MRI may show mucoid or mass-like signal changes within the joint space filled with effusion, representing secondary changes in a chronic stage. Proliferated synovium and denuded bone are prone to bleeding, and idiopathic hemarthrosis will recur in severe OA. In such cases, differential diagnoses include inflammatory arthritis and synovial disorders such as pigmented villonodular synovitis.

Reference

Hayashi D, Guermazi A, Crema MD, Roemer FW. Imaging in osteoarthritis: what have we learned and where are we going? Minerva Med. 2011;102:15–32.

Intra-articular loose body

- In chronic OA, ossified loose bodies may be found within the joint (Fig. 10.3)
- It may appear as if it is continuous with an osteophyte (bony spur)
- Loose bodies may freely move within the joint and may become stuck in a joint space, causing pain and limitation of range of joint movement.
- Intra-articular loose bodies may also be associated with chronic arthritis, OCD, osteochondral fracture, and synovial osteochondromatosis.

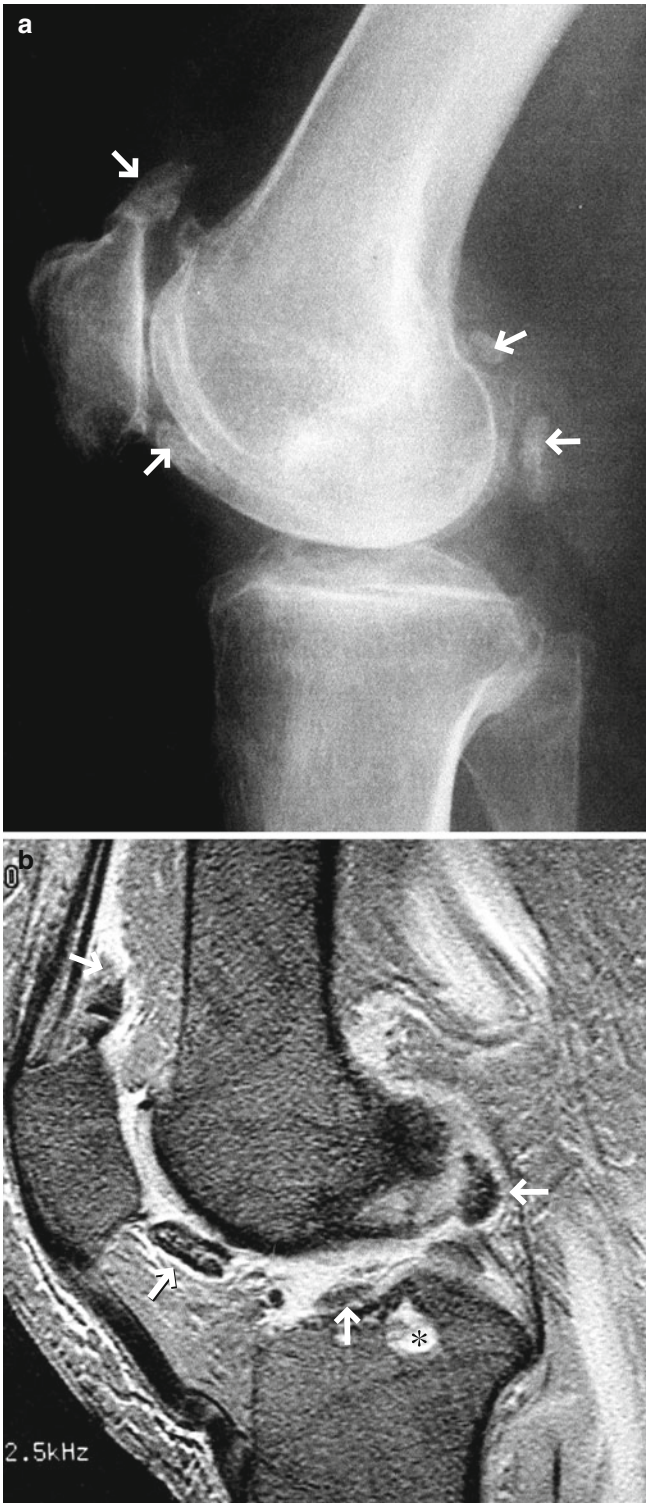

Fig. 10.3 Intra-articular loose body associated with OA. A woman in her 70s. (**a**) Lateral radiograph and (**b**) T2*WI. A large osteophyte is seen at the superior pole of the patella. There are multiple intra-articular ossifications representing loose bodies (*arrows*), which show signal void on MRI. * subchondral cyst

10.2 Spontaneous Osteonecrosis/ Subchondral Insufficiency Fracture

- Occurs specifically in the weight-bearing portion of the medial femoral condyle (see Chap. 8 for differential diagnosis with OCD).
- Precise cause is unknown, but it is thought to be due to mechanical load and meniscal damage.
- Spontaneous osteonecrosis is common in elderly women. However, subchondral insufficiency fracture seems to be more common in middle-aged men.
- May be triggered by excessive intake of alcohol and the use of steroid.
- Most of the spontaneous osteonecrosis is thought to occur following subchondral insufficiency fracture.
- Pain without any trigger may be experienced at night.
- On radiograph, no obvious pathologic findings are seen at an early stage. When the disease reaches an advanced stage, a characteristic lucency surrounded by a sclerotic rim is seen. If the diseases progresses further, there will be joint space narrowing and osteophyte formation, showing OA-like appearance.

References

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Key points for MRI interpretation

- Visualization of spontaneous osteonecrosis at a very early stage is possible.
- Necrotic part shows hypointensity on T1-weighted image, representing loss of normal fatty marrow which shows hyperintensity on T1-weighted image. Deformity and loss of articular cartilage and subchondral bone are delineated (Fig. 10.4).
- In subchondral insufficiency fracture, there is a small lens-like hypointensity in the subchondral bone and the surrounding bone marrow edema at the time of onset. The edema will later regress and may form cystic lesions. Later on, cortical depression will be the only remaining feature (Fig. 10.5).

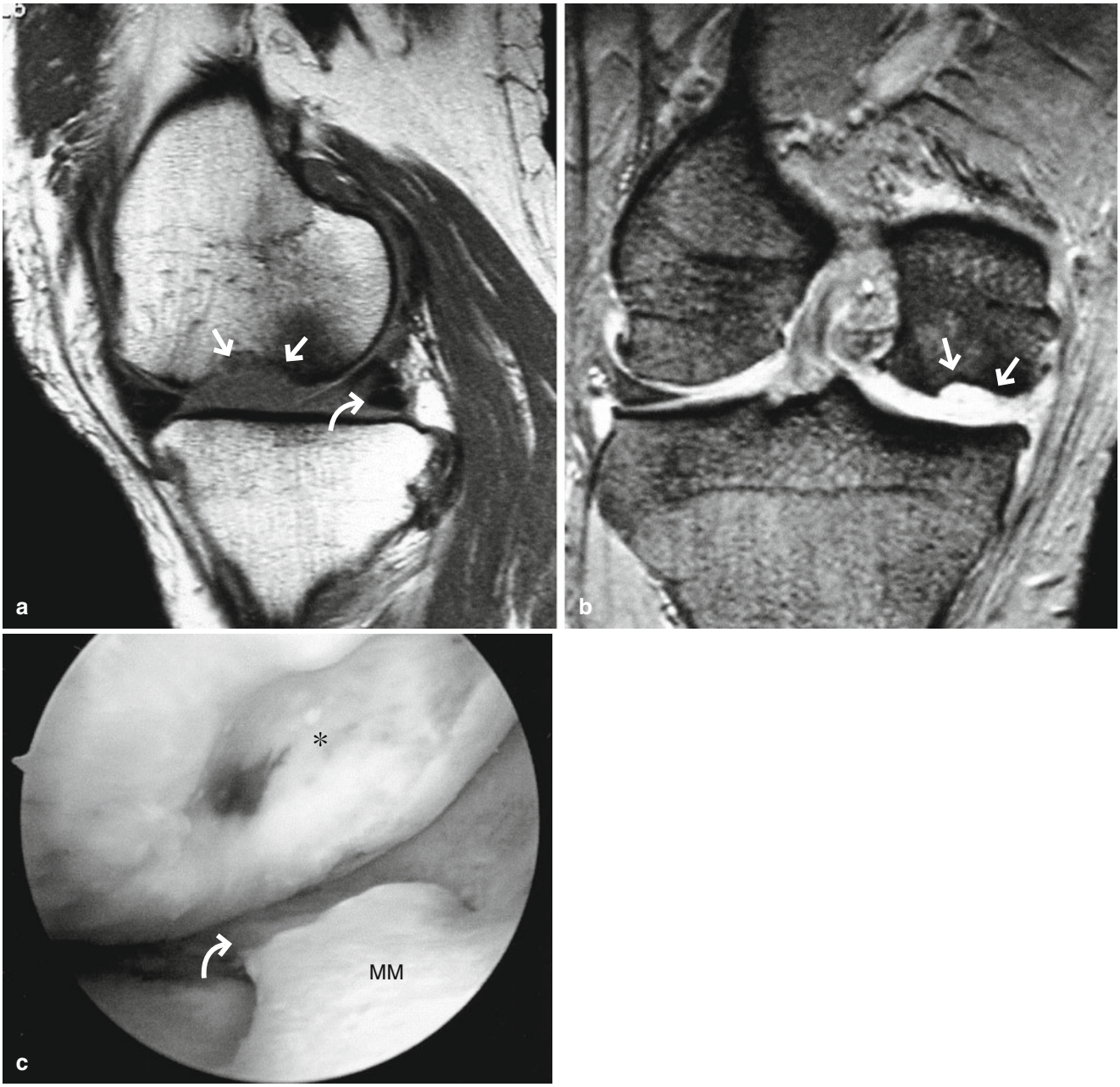

Fig. 10.4 Spontaneous osteonecrosis. A man in his 50s. (**a**) PDWI, (**b**) coronal T2*WI, and (**c**) arthroscopic image. There is a large defect of articular cartilage and subchondral bone at the weight-bearing portion of the medial condyle (*arrows*), and denuded trabecular bone is visible (*). There is a degenerative tear in the posterior segment of the medial meniscus (*curved arrows*)

Fig. 10.5 Subchondral insufficiency fracture. A man in his 60s. (**a**) Coronal FS PDWl and (**b**) PDWl at the time of onset. (**c**, **d**) Taken 6 months later. (**e**, **f**) Taken 1.5 years later. At the time of onset, there is a small lens-like hypointensity in the subchondral bone of the anterior weight-bearing portion of the medial femoral condyle (*arrows*, **a**, **b**). It is surrounded by bone marrow edema (*). Six months later, the edema regressed and a cystic lesion appeared (*arrows*, **c**, **d**). One and a half years later, the only remaining finding is the cortical depression (*arrows*, **e**, **f**)

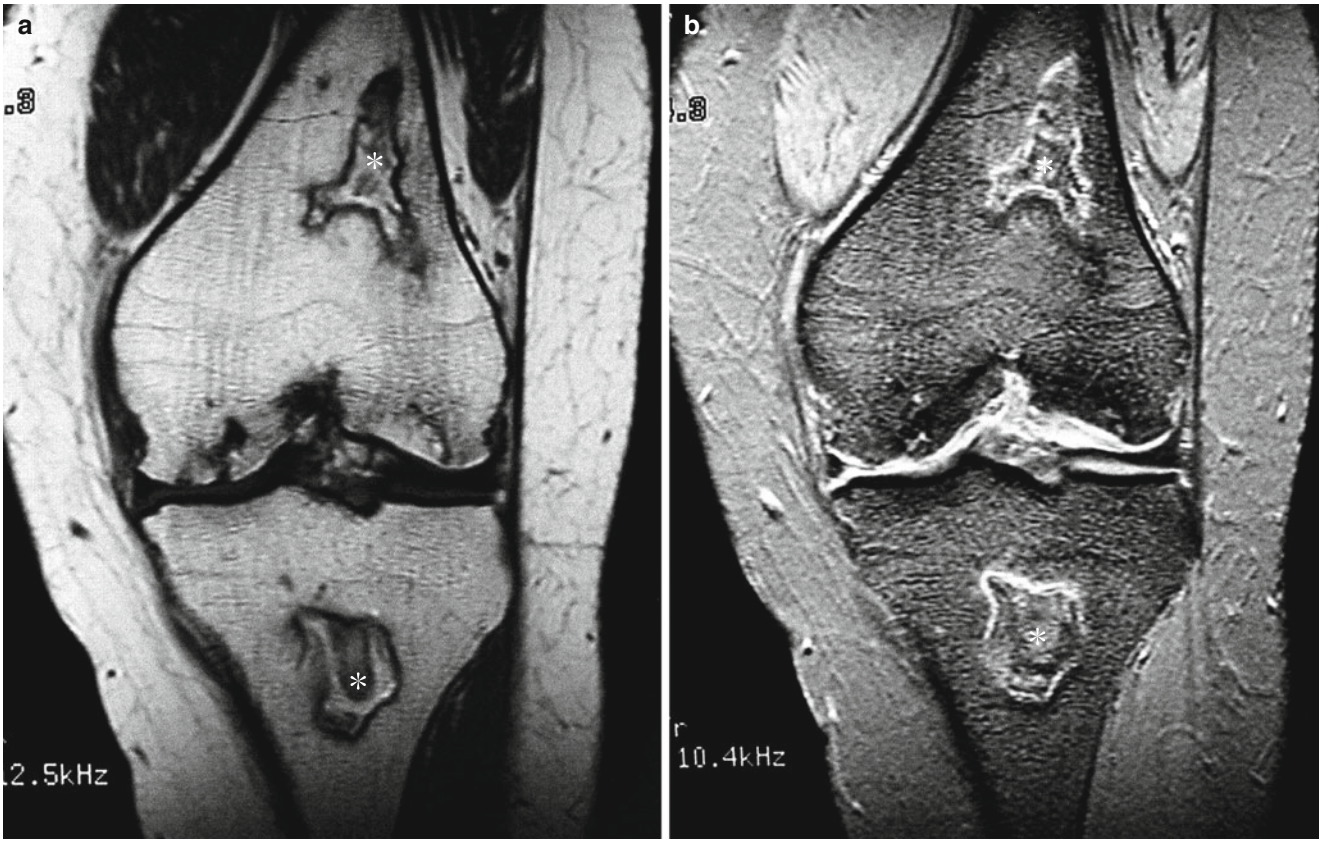

Fig. 10.6 Steroid-induced osteonecrosis. A woman in her 20s, receiving systemic steroid therapy to treat systemic lupus erythematosus. (**a**) Coronal T1WI and (**b**) coronal T2*WI. Necrotic foci are present in the medial and lateral condyle of the femur and tibia, suggesting this is a systemic lesion. The lesion has a rim which shows hypointensity on T1WI and hyperintensity on T2WI, and itself shows inhomogeneous hyperintensity on T1WI (*)

Steroid-induced osteonecrosis

- In patients receiving systemic steroid therapy to treat disease such as systemic lupus erythematosus, systemic sclerosis, rheumatoid arthritis, and post-organ transplantation status, characteristic osteonecrosis occurs, which is distinctly different from spontaneous osteonecrosis.
- The lesion may be present bilaterally, more likely in the lateral than the medial condyle of the femur and tibia. Individual lesion may be large, and its shape is irregular.
- On MRI, the lesion has a rim which shows hypointensity on T1-weighted image and hyperintensity on T2-weighted image. The lesion itself shows inhomogeneous hyperintensity on T1-weighted image, suggestive of fatty necrosis (Fig. 10.6).

10.3 Bone Marrow Reconversion

- Bone marrow around the knee converts from the red (hematopoietic) marrow to the yellow (fatty) marrow as ageing occurs.
- Fatty marrow may reconvert to hematopoietic marrow when a person is subjected to an increased need for hematopoiesis due to severe anemia or other conditions.
- Reconversion starts from the proximal to the distal part of a long bone. Conversely, conversion from the distal to the proximal part.
- Faint areas of hypointensity are present within the hyperintense fatty bone marrow on T1-weighted image or T2-weighted FSE image (Fig. 10.7).
- Histologically, this phenomenon is called hematopoietic hyperplasia. This phenomenon can also be seen in marathon runners who are subjected to strenuous exercise.
- Incidental finding on MRI may (unnecessarily) lead to bone marrow biopsy. However, differentiating this from hematological malignancy such as leukemia on the basis of MRI alone is difficult.

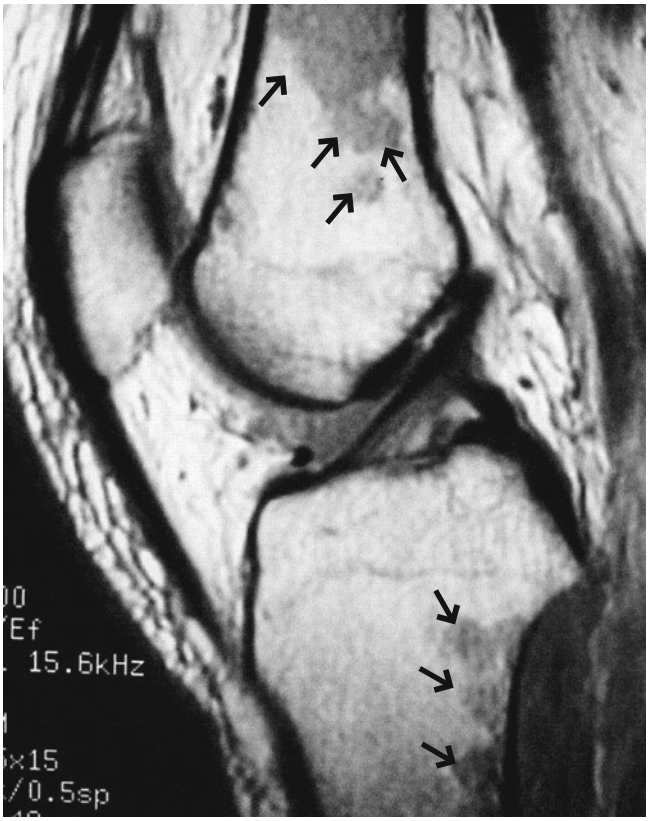

Fig. 10.7 Bone marrow reconversion. A woman in her 40s with a long-term history of severe anemia due to uterine myoma. PDWl shows areas of hypointensity that replace normal fatty marrow (hyperintensity) in the femur and tibia (*arrows*)

References

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Indication of MRI for Imaging of OA

Traditionally, knee MRI has been indicated for imaging diagnosis of trauma such as ligamentous and meniscal injuries in young persons. However, in recent years (in Japan), an increasing number of elderly patients are undergoing knee MRI. This is a result of widespread availability of MR systems in clinical practice. Within the limited amount of examination slots, patients with life-threatening conditions such as cancers and stroke were of course given priorities, and imaging of treatable knee trauma was performed when there were available slots. Nowadays, modern MRI techniques enable improved delineation of articular cartilage, and thus MRI has become increasingly used for imaging of knee OA. Meniscal tear associated with OA can also be diagnosed and treated appropriately, relieving patients of symptoms. Considering the fact that the life expectancy of the Japanese population is rising, use of MRI on elderly patients is expected to rise even further.